Achieving Ultra-High Performance
Guide to Scaling with Kinetex® Columns
Innovation in Particle Technology

The Kinetex® core-shell particle is not fully porous. Using sol-gel processing techniques that incorporate nano structuring technology, a durable, homogenous porous shell is grown on a solid silica core. This highly optimized process combined with uniform particle size distribution produces a column that generates extremely high plate counts on par with sub-2 µm particles. When using Kinetex 2.6 µm core-shell columns, less column backpressure is generated, allowing it to be used on any LC system.**

** When using Kinetex 1.7 µm, increased performance can be achieved, however higher pressure-capable instrumentation is required.

Kinetex 2.6 µm Core-Shell Particle

- Reduced controlled diffusion path maximizes efficiency
- Ultra-high performance on any system with Kinetex 2.6 µm columns

Kinetex 1.7 µm Core-Shell Particle

- Reduced controlled diffusion path maximizes efficiency
- Increased efficiencies compared to traditional fully porous sub-2 µm columns. Typical operating backpressures > 400 bar

Traditional Fully Porous Particle

- Long and variable diffusion path limits efficiencies
- Ultra-high performance limited to UHPLC systems with traditional fully porous sub-2 µm columns

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Increase Efficiency with Kinetex® Core-Shell Technology

Column efficiency (N), the measure of theoretical plates over a given length, is one of the most important indicators of column performance. Efficiency is heavily influenced by:

- Column length
- Particle size

This relationship can be illustrated with the following equation:

\[ N = \frac{L}{H} \]

- \( L \) = Column Length (mm)
- \( H \) = Plate Height
- \( N \) = Efficiency (plates)
- \( h \) = Reduced Plate Height
  (Typically 2-2.5, assume 2.2 for calculations)
- \( d_p \) = Particle Diameter (mm)

Using this equation, a column's theoretical efficiency may be estimated.

Example:

- A 150 x 4.6 mm 5 µm column would have its efficiency calculated as follows:

  \[ N = \frac{150}{(2.2)\cdot0.005} \Rightarrow N = \frac{150}{.011} \Rightarrow N = 13,636 \text{ plates} \]

- Then, to convert to plates/ meter

  \[ N_{p/m} = \left\{ \frac{13636 \text{ plates}}{\text{length of column (mm)}} \right\} \times 1000 \text{ mm/m} \]

  \[ N_{p/m} = (13636 / 150 \text{ mm}) \times 1000 \text{ mm/m} = 90,906 \text{ p/m} \]

Smaller particle size columns will produce higher efficiencies.
Increase Efficiency with Kinetex® Core-Shell Technology

In order to more accurately predict the efficiency of Kinetex columns using the efficiency equation, an effective particle size \( d_e \) of 1.7 \( \mu \text{m} \) must be used (Figure 1). As such:

- An effective \( d_e \) of 1.7 \( \mu \text{m} \) is used for Kinetex 2.6 \( \mu \text{m} \) particles
- An effective \( d_e \) of 1.5 \( \mu \text{m} \) is used for Kinetex 1.7 \( \mu \text{m} \) particles

**Figure 1.** van Deemter plot of Fully Porous 3 and 1.7 \( \mu \text{m} \) Column, and the Kinetex 2.6 \( \mu \text{m} \) Core-Shell Column

Kinetex 2.6 \( \mu \text{m} \) columns have the efficiency of a 1.7 \( \mu \text{m} \) particle. This has been experimentally proven in multiple van Deemter experiments (See Figure 1).

**What would be the calculated change in Efficiency from...**

A 10 \( \mu \text{m} \) Fully Porous Media to a Kinetex 2.6 \( \mu \text{m} \) Media?

\[
\Delta N = \frac{d_p}{d_e} \quad \Delta N = \frac{10}{1.7} \quad \Delta N = 5.88
\]

Approximately 6x Increase in Efficiency

A 5 \( \mu \text{m} \) Fully Porous Media to a Kinetex 2.6 \( \mu \text{m} \) Media?

\[
\Delta N = \frac{d_p}{d_e} \quad \Delta N = \frac{5}{1.7} \quad \Delta N = 2.94
\]

Approximately 3x Increase in Efficiency

A 3 \( \mu \text{m} \) Fully Porous Media to a Kinetex 2.6 \( \mu \text{m} \) Media?

\[
\Delta N = \frac{d_p}{d_e} \quad \Delta N = \frac{3}{1.7} \quad \Delta N = 1.76
\]

Approximately 2x Increase in Efficiency

A 2.5 \( \mu \text{m} \) Fully Porous Media to a Kinetex 2.6 \( \mu \text{m} \) Media?

\[
\Delta N = \frac{d_p}{d_e} \quad \Delta N = \frac{2.5}{1.7} \quad \Delta N = 1.47
\]

Approximately 1.5x Increase in Efficiency

A 1.7 \( \mu \text{m} \) Fully Porous Media to a Kinetex 2.6 \( \mu \text{m} \) Media?

\[
\Delta N = \frac{d_p}{d_e} \quad \Delta N = \frac{1.7}{1.7} \quad \Delta N = 1
\]

Same Efficiency
Increase Resolution

What is resolution?

Resolution ($R_s$) describes the separation power of the complete chromatographic system relative to the components of the mixture. Through obtaining optimal resolution, scientists are able to:

1. Identify more compounds
2. Decrease run times
3. Increase solvent savings

$$R_s = \frac{\sqrt{N}}{4} \left( \frac{\alpha - 1}{\alpha} \right) \left( \frac{k}{k + 1} \right)$$

Resolution is proportional to the square root of $N$ (the column efficiency)

| Compounds are baseline resolved when resolution is ≥ 1.5 |
| Compounds are not baseline resolved when resolution is < 1.5. |

It is clear that large increases in efficiency can significantly increase resolution.

Example:

If column efficiency triples, by going from a 5 µm column to a Kinetex® 2.6 µm column of equivalent dimensions (see pg. 5), what would be the expected impact to resolution?

With a 3x increase in efficiency ($\Delta N=3$)

Resolution will increase by $\sqrt{3} \rightarrow 73 \%$ increase in Resolution

If I am using a 5 µm 150 mm length column and have a critical pair with a resolution of only 1.3, could I expect to get baseline resolution with a Kinetex column of equivalent dimension?

Yes!

$$N = \frac{5}{1.7} \rightarrow R_{\text{scaling factor}} = \sqrt{3} \rightarrow R_{\text{scaling factor}} = 1.73 \rightarrow R_s = 1.3 \times 1.73 \rightarrow R_{\text{final}} = 2.25$$
Increase Resolution

**EP Method for Atenolol and Related Impurities**

**EP Specified 5 µm C18 Column**

Conditions same for both columns except as noted:

- **Flow Rate:** 0.6 mL/min
- **Mobile Phase:** 12.5 mM Phosphoric acid in Water, pH 3.0 + 2.0 g Sodium Octanesulfonate + 0.8 g Tetrabutyl Ammonium Hydrogen Sulfate / Methanol / THF (80:18:2)
- **Temperature:** 22 ºC
- **Detection:** UV @ 226 nm

Sample: Atenolol Related Substance
- 1. Impurity B
- 2. Impurity A
- 3. Impurity J
- 4. Impurity I
- 5. Impurities D and E
- 6. Impurity F
- 7. Impurity G
- 8. Impurity H

**Substitute with Kinetex® C18**

Conditions same for both columns except as noted:

- **Flow Rate:** 0.6 mL/min
- **Mobile Phase:** 12.5 mM Phosphoric acid in Water, pH 3.0 + 2.0 g Sodium Octanesulfonate + 0.8 g Tetrabutyl Ammonium Hydrogen Sulfate / Methanol / THF (80:18:2)
- **Temperature:** 22 ºC
- **Detection:** UV @ 226 nm

Sample: Atenolol Related Substance
- 1. Impurity B
- 2. Impurity A
- 3. Impurity J
- 4. Impurity I
- 5. Impurities D and E
- 6. Impurity F
- 7. Impurity G
- 8. Impurity H

**READ ME!**

Can this be done by going to a fully porous 1.7 µm particle?

Yes. Except the 3x increase in resolution comes with a 9x increase in backpressure.

\[
\Delta P = \frac{\phi \eta L \mu}{d_p^2}
\]

- \(\mu\) = Linear Velocity
- \(L\) = Column Length
- \(d_p\) = Particle Diameter
- \(\phi\) = Flow Resistance Parameter
- \(\eta\) = Mobile Phase Viscosity

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Increase Resolution

Kinetex® columns are the highest efficiency columns sold today. Selecting an equivalent length Kinetex column and optimizing flow for the particle will provide the highest Rs.

**Isocratic Separations**

A. Scale the flow rate to achieve the same mobile phase linear velocity with the new column ID.

\[
\text{Flow Rate}_{\text{Kinetex}} = \text{Flow Rate}_{\text{Original}} \times \left(\frac{\text{diameter}_{\text{Kinetex}}}{\text{diameter}_{\text{Original}}}\right)^2
\]

**Example:** 1 mL/min flow rate 4.6 mm ID to 3.0 mm ID

\[
1 \text{ mL/min} \times \left(\frac{3.0 \text{ mm}}{4.6 \text{ mm}}\right)^2 = 0.43 \text{ mL/min}
\]

Note: considerations should be made for system backpressure & flow rate limitations.

B. Scale the injection volume to account for change in column ID.

\[
\text{Inj.vol.}_{\text{Kinetex}} = \text{Inj.vol.}_{\text{Original}} \times \left(\frac{\text{diameter}_{\text{Kinetex}}}{\text{diameter}_{\text{Original}}}\right)^2
\]

The mobile phase linear velocity may be adjusted in line with the reduced effective particle size.

\[
\text{Flow Rate}_{\text{Kinetex}} \times \left(\frac{d_p\text{ Original}}{d_p\text{ Kinetex}}\right)
\]

---

**Effective particle size of Kinetex (d_e)**

- Kinetex 2.6 µm = 1.7 µm
- Kinetex 1.7 µm = 1.5 µm

Note: Scale the flow rate to achieve the same mobile phase linear velocity with the new column ID.
Increase Resolution

**Gradient Separations**

A. Scale the flow rate to achieve the same mobile phase linear velocity with the new column ID.

\[
Flow \ Rate_{\text{Kinetex}} = Flow \ Rate_{\text{Original}} \times \left(\frac{\text{diameter}_{\text{Kinetex}}}{\text{diameter}_{\text{Original}}}\right)^2
\]

B. Scale the injection volume to account for change in column ID.

\[
\text{Inj.\,vol.}_{\text{Kinetex}} = \text{Inj.\,vol.}_{\text{Original}} \times \left(\frac{\text{diameter}_{\text{Kinetex}}}{\text{diameter}_{\text{Original}}}\right)^2
\]

C. To match your original gradient program, adjust the time segment at each step to maintain the same column volume (cv) per unit time. The calculated time segment will take into account changes in column ID, flow rate, and column length.

\[
\text{Time \ Segment}_{\text{Kinetex}} = \text{Time \ Segment}_{\text{Original}} \times \left(\frac{\text{ID}_{\text{Kinetex}}}{\text{ID}_{\text{Original}}}\right)^2 \times \left(\frac{\text{Flow \ Rate}_{\text{Original}}}{\text{Flow \ Rate}_{\text{Kinetex}}}\right) \times \left(\frac{\text{Column \ Length}_{\text{Kinetex}}}{\text{Column \ Length}_{\text{Original}}}\right)
\]

The mobile phase linear velocity may be adjusted in line with the reduced effective particle size.

\[
Flow \ Rate_{\text{Kinetex}} = \left(\frac{d_p}{d_p} \text{Kinetex}\right)
\]
Increase Productivity

Productivity may be defined as: unit resolution per unit time

Resolution must be maintained as run time is reduced or no improvement in productivity is realized.

To choose the correct length Kinetex® column for increasing productivity, we recommend using a simple ratio comparison:

\[
\frac{\text{Column Length}_{\text{Original}}}{d_p \text{ Original}} : \frac{\text{Column Length}_{\text{Kinetex}}}{d_e \text{ Kinetex}}
\]

A comparison of these ratios will be indicative of the difference in resolution power between the two columns. A shorter Kinetex column, providing the resolving power of the original column, will maintain resolution while decreasing run time.

**Comparison Examples**

<table>
<thead>
<tr>
<th>Effective Length/Particle Size</th>
<th>Unit Conversion</th>
<th>Column Efficiency Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 mm/5 µm</td>
<td>250 mm/.005 mm</td>
<td>50,000</td>
</tr>
<tr>
<td>100 mm/1.7 µm</td>
<td>100 mm/.0017 mm</td>
<td>58,825</td>
</tr>
<tr>
<td>This indicates that a similar resolution can be found between these two columns.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 150 mm/3 µm                   | 150 mm/.003 mm  | 50,000                       |
| 100 mm/1.7 µm                 | 100 mm/.0017 mm | 58,825                       |
| This indicates that a similar resolution can be found between these two columns. |
Increase Productivity

Isocratic Separations

A. Choose the correct Kinetex® column:

\[
\frac{d_p \text{ Original}}{d_e \text{ Kinetex}} : \frac{d_p \text{ Kinetex}}{d_e \text{ Kinetex}}
\]

B. Scale the flow rate to achieve the same mobile phase linear velocity with a new column ID.

\[
\text{Flow Rate}_{\text{Kinetex}} = \text{Flow Rate}_{\text{Original}} \times \left(\frac{diameter_{\text{Kinetex}}}{diameter_{\text{Original}}}\right)^2
\]

The mobile phase linear velocity may be adjusted in line with the reduced effective particle size.

\[
\text{Flow Rate}_{\text{Kinetex}} = \text{Flow Rate}_{\text{Original}} \times \left(\frac{diameter_{\text{Kinetex}}}{diameter_{\text{Original}}}\right)
\]

Gradient Separations

A. Choose the correct Kinetex® column:

\[
\frac{d_p \text{ Original}}{d_e \text{ Kinetex}} : \frac{d_p \text{ Kinetex}}{d_e \text{ Kinetex}}
\]

B. Scale the flow rate to achieve the same mobile phase linear velocity with a new column ID.

\[
\text{Flow Rate}_{\text{Kinetex}} = \text{Flow Rate}_{\text{Original}} \times \left(\frac{diameter_{\text{Kinetex}}}{diameter_{\text{Original}}}\right)^2
\]

C. To match your original gradient program, adjust the time segment at each step to account for any changes in flow rate, ID, and column length:

\[
\text{Time Segment}_{\text{Kinetex}} = \text{Time Segment}_{\text{Original}} \times \left(\frac{Column Length_{\text{Kinetex}}}{Column Length_{\text{Original}}}\right) \times \left(\frac{\text{Flow Rate}_{\text{Kinetex}}}{\text{Flow Rate}_{\text{Original}}}\right) \times \left(\frac{ID_{\text{Kinetex}}}{ID_{\text{Original}}}\right)^2
\]

\[
\text{Flow Rate}_{\text{Kinetex}} = \text{Flow Rate}_{\text{Original}} \times \left(\frac{diameter_{\text{Kinetex}}}{diameter_{\text{Original}}}\right)
\]

Remember to scale your injection volume for any change in column ID.
Increase Throughput

Optimum throughput is achieved by decreasing total analysis time as much as possible while maintaining acceptable chromatographic performance ($R_s \geq 1.5$).

Conventional way to increase throughput

Fully Porous 5 µm 250 x 4.6 mm
$R_s = 2.0$

Fully Porous 3 µm 150 x 4.6 mm
$R_s = 2.0$

$R_s = \text{no change}$

Throughput = 1.7x Increase

Kinetex® way to increase throughput

Fully Porous 5 µm 250 x 4.6 mm
$R_s = 2.0$

Kinetex 2.6 µm 150 x 4.6 mm
$R_s = 2.65$

$R_s = 1.3x$

Throughput = 1.7x Increase

Optional: Increase flow rate 3x for particle size adjustment.
5x Increase in Throughput

Fully Porous 5 µm 250 x 4.6 mm
$R_s = 2.0$

Kinetex 2.6 µm 100 x 4.6 mm
$R_s = 2.17$

$R_s = 1.1x$

Throughput = 2.5x Increase

Optional: Increase flow rate 3x for particle size adjustment.
7.5x Increase in Throughput

Fully Porous 5 µm 250 x 4.6 mm
$R_s = 2.0$

Kinetex 2.6 µm 50 x 4.6 mm
$R_s = 1.53$

$R_s = 0.77x$

Throughput = 5x Increase

Optional: Increase flow rate 3x for particle size adjustment.
15x Increase in Throughput

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Increase Throughput

16x Increase in Throughput

R, 5, 6 = 3.4

25x Increase in Throughput!

R, 5, 6 = 3.2

Columns: Kinetex® 2.6 µm C18
Dimensions: 50 x 4.6 mm
Part No.: 008-4462-EO
Mobile Phase: A: 0.1% Formic acid / Water
B: 0.1% Formic acid / Acetonitrile
Gradient:

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Time (min)</th>
<th>% A</th>
<th>% B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>0.20</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>3.</td>
<td>2.47</td>
<td>5</td>
<td>95</td>
</tr>
<tr>
<td>4.</td>
<td>3.47</td>
<td>95</td>
<td>5</td>
</tr>
</tbody>
</table>

Flow Rate: 3.94 mL/min
Temperature: 45 °C
Detection: UV @ 254 nm (25 °C)
Backpressure: 106 bar

Sample:

1. Pyridine
2. Acetaminophen
3. Quinine
4. Acetobutol
5. Chlorpheniramine
6. Triprolidine
7. Prednisolone
8. 4-Chlorobenzoic acid
9. 4-Chlorocinnamic acid
10. Diazepam
11. Diffusional
12. Hexanaphone

R, 5, 6 = 3.0

Columns: Fully Porous 5 µm C18(2)
Dimensions: 250 x 4.6 mm
Part No.: 008-4462-EO
Mobile Phase: A: 0.1% Formic acid / Water
B: 0.1% Formic acid / Acetonitrile
Gradient:

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Time (min)</th>
<th>% A</th>
<th>% B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>2.79</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>3.</td>
<td>3.65</td>
<td>5</td>
<td>95</td>
</tr>
<tr>
<td>4.</td>
<td>3.68</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>5.09</td>
<td>95</td>
<td>5</td>
</tr>
</tbody>
</table>

Flow Rate: 1 mL/min
Temperature: 45 °C
Detection: UV @ 254 nm (25 °C)
Backpressure: 485 bar

Sample:

1. Pyridine
2. Acetaminophen
3. Quinine
4. Acetobutol
5. Chlorpheniramine
6. Triprolidine
7. Prednisolone
8. 4-Chlorobenzoic acid
9. 4-Chlorocinnamic acid
10. Diazepam
11. Diffusional
12. Hexanaphone

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Choosing the Best Kinetex® Column

Expected Backpressure at Different Flow Rates*
There is an optimal Kinetex column for your system and operating conditions. Use these graphs to determine the starting Kinetex particle size and dimension for your method.

Material Characteristics

<table>
<thead>
<tr>
<th>Packing Material</th>
<th>Total Particle Size (µm)</th>
<th>Porous Shell (µm)</th>
<th>Solid Core (µm)</th>
<th>Pore Size (Å)</th>
<th>Effective Surface Area (m²/g)</th>
<th>Effective Carbon Load %</th>
<th>pH Stability</th>
<th>Pressure Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinetex C18</td>
<td>2.6</td>
<td>0.35</td>
<td>1.9</td>
<td>100</td>
<td>200</td>
<td>10</td>
<td>1.5-10</td>
<td>600 bar</td>
</tr>
<tr>
<td>Kinetex XB-C18</td>
<td>2.6</td>
<td>0.35</td>
<td>1.9</td>
<td>100</td>
<td>200</td>
<td>10</td>
<td>1.5-10</td>
<td></td>
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<tr>
<td>Kinetex C8</td>
<td>2.6</td>
<td>0.35</td>
<td>1.9</td>
<td>100</td>
<td>200</td>
<td>8</td>
<td>1.5-10</td>
<td></td>
</tr>
<tr>
<td>Kinetex PFP</td>
<td>2.6</td>
<td>0.35</td>
<td>1.9</td>
<td>100</td>
<td>200</td>
<td>9</td>
<td>1.5-8.0</td>
<td></td>
</tr>
<tr>
<td>Kinetex HILIC</td>
<td>2.6</td>
<td>0.35</td>
<td>1.9</td>
<td>100</td>
<td>200</td>
<td>0</td>
<td>2.0-7.5</td>
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<tr>
<td>Kinetex C18</td>
<td>1.7</td>
<td>0.23</td>
<td>1.25</td>
<td>100</td>
<td>200</td>
<td>12</td>
<td>1.5-10</td>
<td></td>
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<tr>
<td>Kinetex XB-C18</td>
<td>1.7</td>
<td>0.23</td>
<td>1.25</td>
<td>100</td>
<td>200</td>
<td>10</td>
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<td></td>
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<tr>
<td>Kinetex C8</td>
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<td>Kinetex PFP</td>
<td>1.7</td>
<td>0.23</td>
<td>1.25</td>
<td>100</td>
<td>200</td>
<td>9</td>
<td>1.5-8.0</td>
<td></td>
</tr>
<tr>
<td>Kinetex HILIC</td>
<td>1.7</td>
<td>0.23</td>
<td>1.25</td>
<td>100</td>
<td>200</td>
<td>0</td>
<td>2.0-7.5</td>
<td></td>
</tr>
</tbody>
</table>

*Due to variation in system, sample and method parameters, graphs provided may not be representative of all applications.
Data generated on Agilent 1200 SL.

KINETEX CALCULATOR!
Instantly optimize your method at www.phenomenex.com/optimize OR contact Your Phenomenex representative for optimization assistance.
Ordering Information

Kinetex® 2.6 μm Analytical Columns (mm)

<table>
<thead>
<tr>
<th>Column Description</th>
<th>Part No.</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>XB-C18</td>
<td>00B-4496-E0 00D-4496-E0 00F-4496-E0</td>
<td></td>
</tr>
<tr>
<td>C18</td>
<td>00A-4462-E0 00B-4462-E0 00C-4462-E0</td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>00B-4497-E0 00D-4497-E0 00F-4497-E0</td>
<td></td>
</tr>
<tr>
<td>PFP</td>
<td>00A-4477-E0 00B-4477-E0 00C-4477-E0</td>
<td></td>
</tr>
<tr>
<td>HI-LIC</td>
<td>00B-4461-E0 00D-4461-E0 00F-4461-E0</td>
<td></td>
</tr>
</tbody>
</table>

Kinetex 2.6 μm MidBore™ Columns (mm)

<table>
<thead>
<tr>
<th>Column Description</th>
<th>Part No.</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>XB-C18</td>
<td>00B-4496-Y0 00D-4496-Y0 00F-4496-Y0</td>
<td></td>
</tr>
<tr>
<td>C18</td>
<td>00A-4462-Y0 00B-4462-Y0 00C-4462-Y0</td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>00B-4497-Y0 00D-4497-Y0 00F-4497-Y0</td>
<td></td>
</tr>
<tr>
<td>PFP</td>
<td>00A-4477-Y0 00B-4477-Y0 00C-4477-Y0</td>
<td></td>
</tr>
<tr>
<td>HI-LIC</td>
<td>00B-4461-Y0 00D-4461-Y0 00F-4461-Y0</td>
<td></td>
</tr>
</tbody>
</table>

Kinetex 2.6 μm Minibore Columns (mm)

<table>
<thead>
<tr>
<th>Column Description</th>
<th>Part No.</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>XB-C18</td>
<td>00B-4496-AN 00D-4496-AN 00F-4496-AN</td>
<td></td>
</tr>
<tr>
<td>C18</td>
<td>00A-4462-AN 00B-4462-AN 00C-4462-AN</td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>00B-4497-AN 00D-4497-AN 00F-4497-AN</td>
<td></td>
</tr>
<tr>
<td>PFP</td>
<td>00A-4477-AN 00B-4477-AN 00C-4477-AN</td>
<td></td>
</tr>
<tr>
<td>HI-LIC</td>
<td>00B-4461-AN 00D-4461-AN 00F-4461-AN</td>
<td></td>
</tr>
</tbody>
</table>

Kinetex 1.7 μm Minibore Columns (mm)

<table>
<thead>
<tr>
<th>Column Description</th>
<th>Part No.</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>XB-C18</td>
<td>00B-4498-AN 00D-4498-AN</td>
<td></td>
</tr>
<tr>
<td>C18</td>
<td>00B-4475-AN 00D-4475-AN 00F-4475-AN</td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>00B-4499-AN 00D-4499-AN 00F-4499-AN</td>
<td></td>
</tr>
<tr>
<td>PFP</td>
<td>00B-4476-AN 00D-4476-AN 00F-4476-AN</td>
<td></td>
</tr>
<tr>
<td>HI-LIC</td>
<td>00B-4474-AN 00D-4474-AN 00F-4474-AN</td>
<td></td>
</tr>
</tbody>
</table>

Phenex™ RC (Regenerated Cellulose) Syringe Filters

- Rapid filtration of HPLC and GC samples prior to analysis
- Particulate, PVC, and extractable-free filters
- Universal filter compatible with both aqueous and mixed organic solutions

Choose filter diameter based on sample volume

<table>
<thead>
<tr>
<th>Membrane Type/Size</th>
<th>Part No.</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenex-RC (Regenerated Cellulose)</td>
<td>AF0-3203-12</td>
<td>100/ pk</td>
</tr>
<tr>
<td>Phenex-RC (Regenerated Cellulose)</td>
<td>AF0-3203-52</td>
<td>500/ pk</td>
</tr>
<tr>
<td>Phenex-RC (Regenerated Cellulose)</td>
<td>AF0-8203-12</td>
<td>100/ pk</td>
</tr>
</tbody>
</table>

KrudKatcher™ Ultra In-line Filter

- Disposable in-line filter fits virtually all UHPLC / HPLC columns 1.0 to 4.6 mm
- Extremely low dead-volume minimizes sample peak dispersion
- Pressure rated to 1375 bar (20,000 psi) (see p. 15 for more information)

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF0-8497</td>
<td>KrudKatcher Ultra In-Line Filter, 0.5 µm Porosity x 0.004 in. ID</td>
<td>3/pk</td>
</tr>
</tbody>
</table>

Note: AF0-8497 is 25 mm diameter.

3 batch method validation kits available upon request

www.phenomenex.com
If you are not completely satisfied with Kinetex® core-shell columns, send in your comparative data to a similar product within 45 days and KEEP THE COLUMN FOR FREE.